University PV Processes and Products Development Support

DOE Solar Energy Technologies Program

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University Product and Process Development Objectives

Leverage universities' fundamental understanding of materials and photovoltaic (PV) devices

- Accelerate transition of PV technology from laboratory to marketplace.
- Help industry efficiently develop and optimize manufacturing processes.

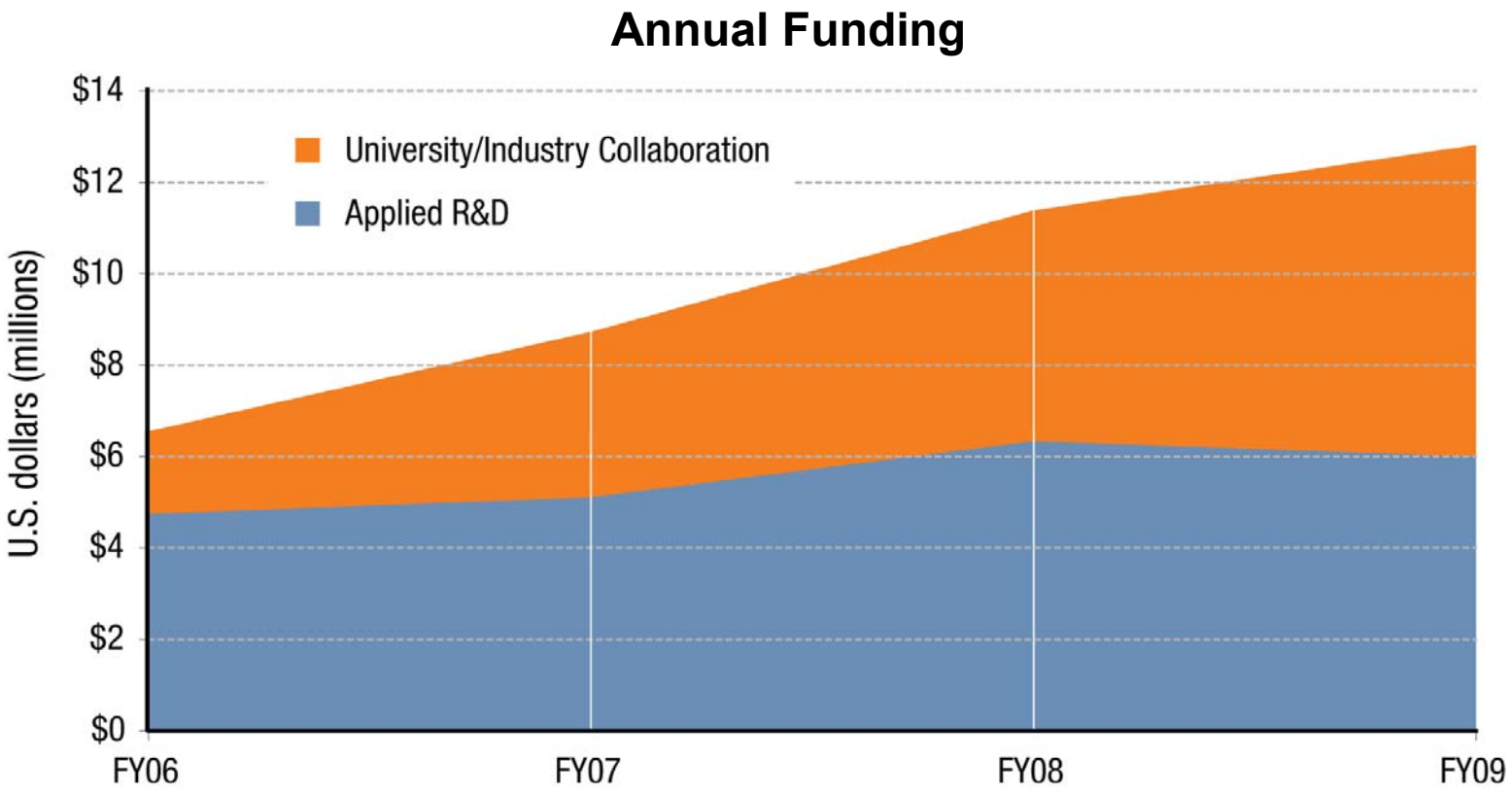
Strengthen university involvement in rapidly expanding PV industry

- Form direct project partnerships between leading U.S. companies and proven university research groups.
- Provide clear strategies to move products and processes into commercial production.

Expand the domestic PV R&D workforce

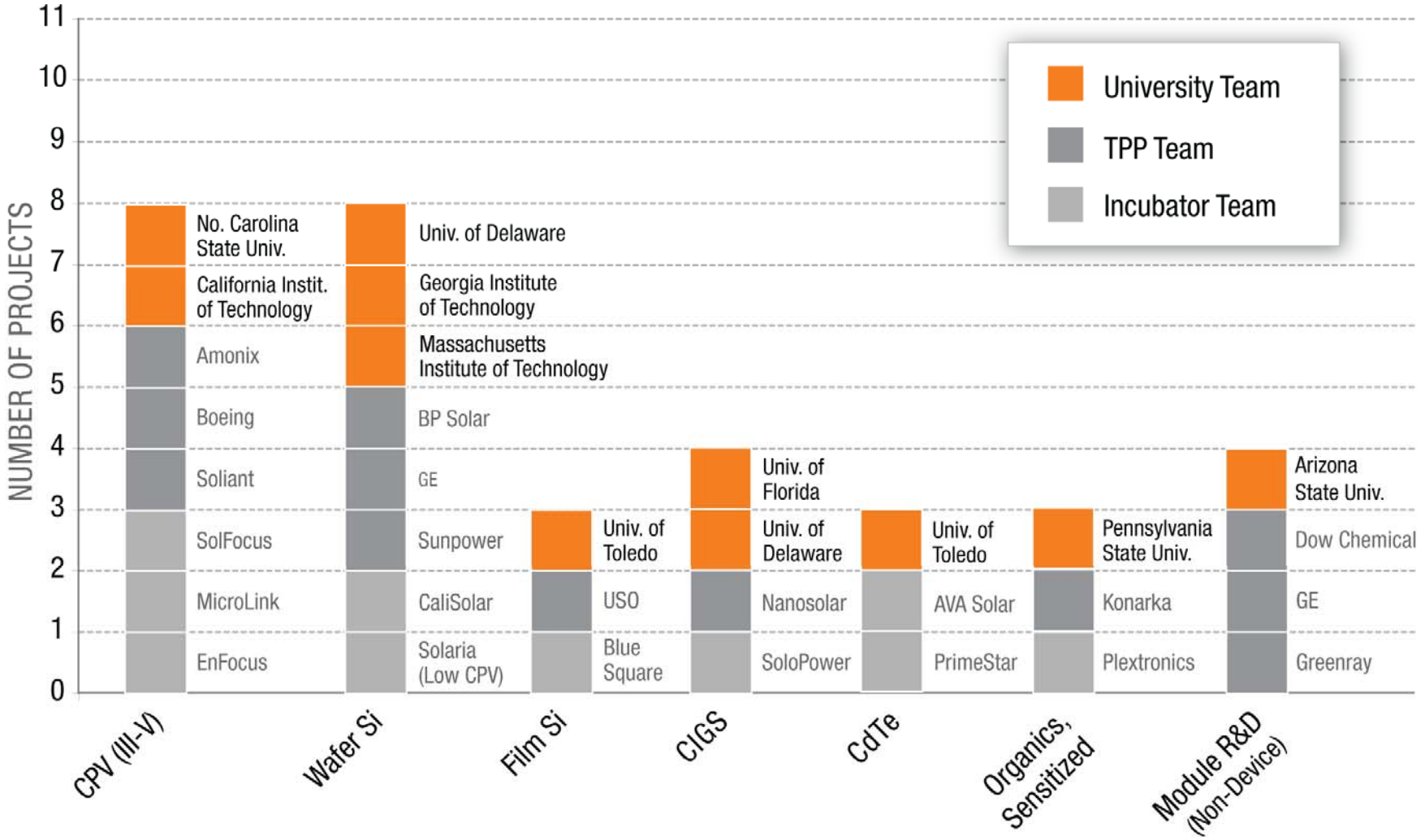
- Expose students to growing PV-related commercialization efforts.
- Supply industry with a stream of qualified scientists.

Under the Solar America Initiative, DOE has increased university collaboration with industry while maintaining commitment to longer term R&D projects.

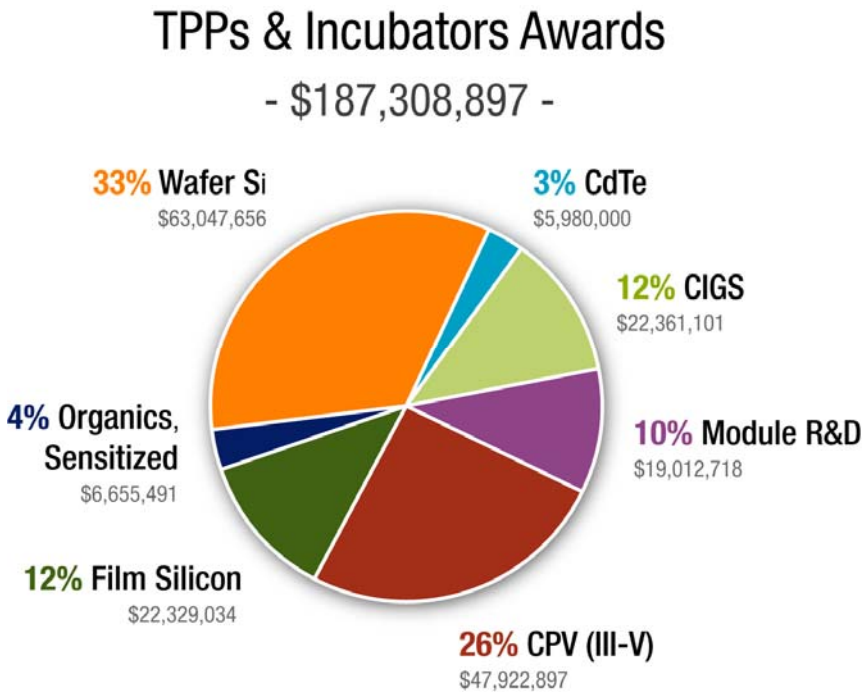


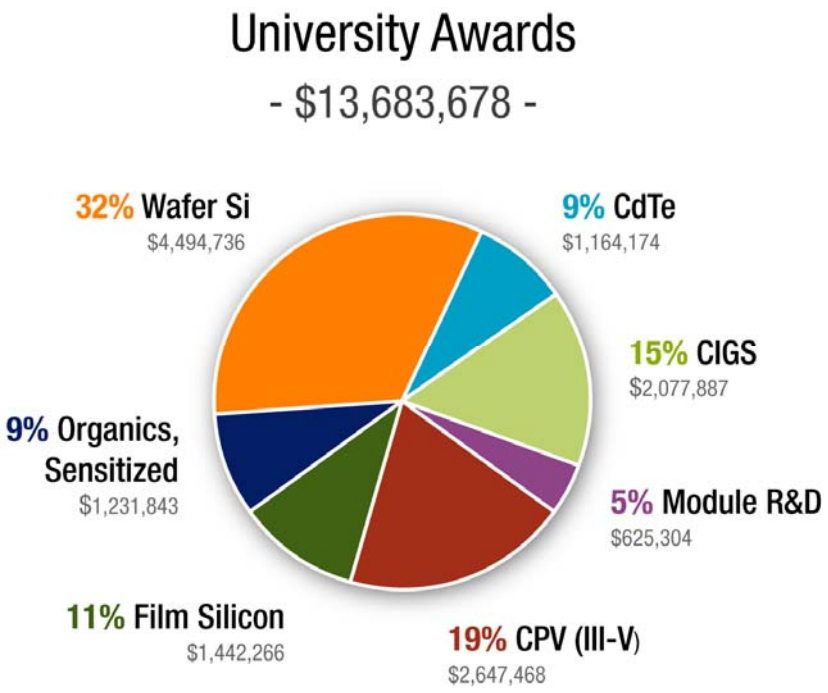
University funding increases commensurate with PV budget increase under the SAI

Distribution of projects across technology types.



University Product and Process Development funding remains aligned with current industry targeted programs.



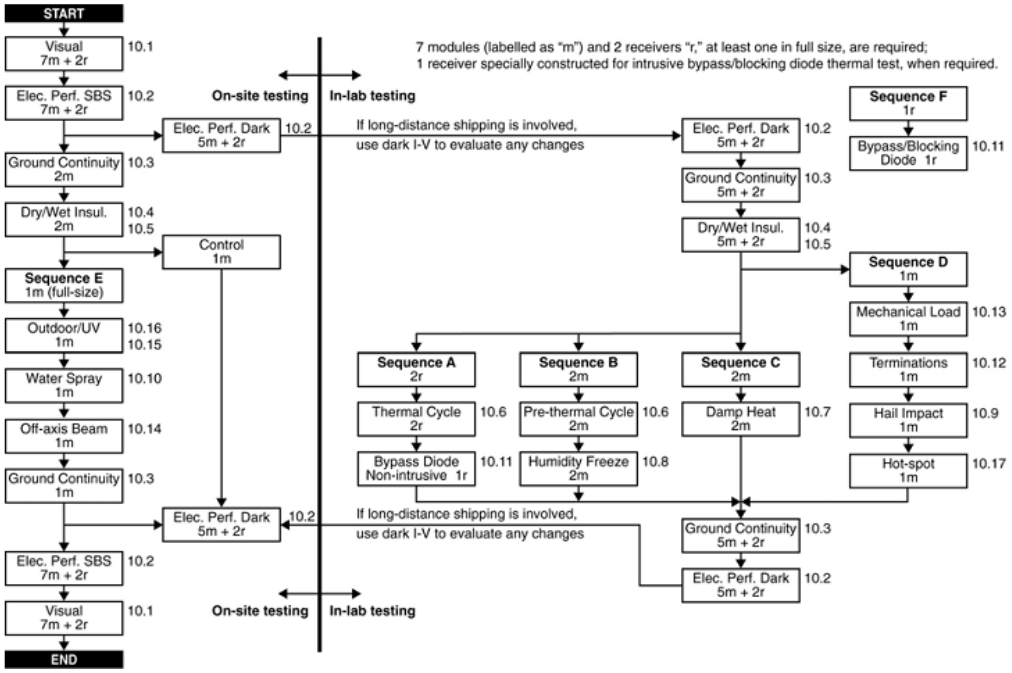


Selected Projects:
University PV Processes and Products Development Support

Arizona State University
with SolFocus, Inc. and Soliant Energy, Inc.

Reliability Evaluation of Concentrator Photovoltaics per IEC Qualification Specifications

Technologies Addressed
Product qualification process for concentrating PV modules
Description
Reduce qualification bottlenecks such as environmental chamber testing while enhancing scheduling and coordination with industry to significantly increase testing throughput and efficiency.
Project Target — **IEC testing costs and time reduced by as high as 65%**

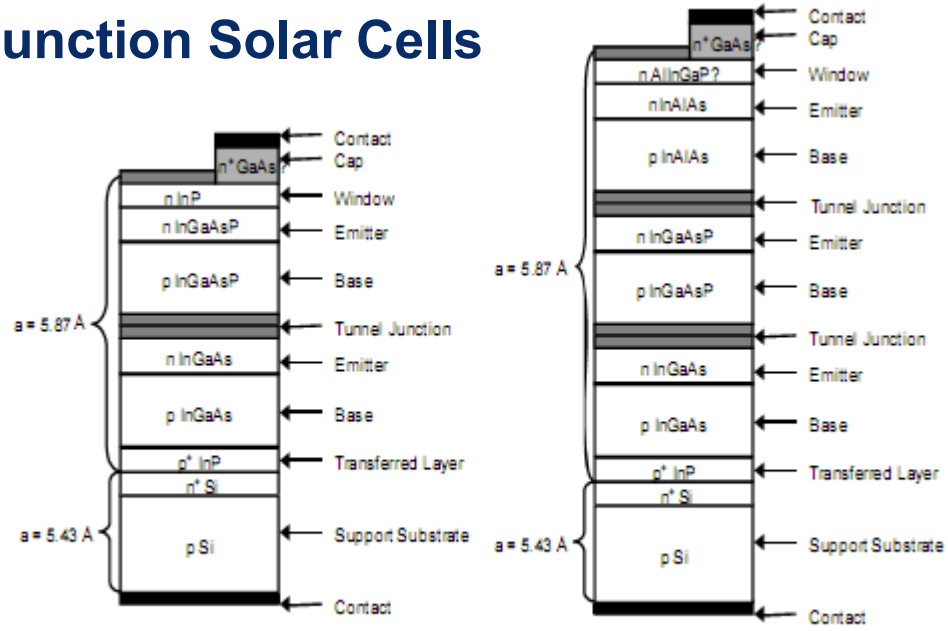


Resources ($)		
Total Project	DOE Funds	Cost Share
$785,304	**$625,304**	**$160,000**

California Institute of Technology
with Spectrolab, Inc.

100mm Engineered InP on Si Laminate Substrates for InP based Multijunction Solar Cells

Technologies Addressed
Thin InP on inexpensive Si substrate for low cost multijunction cells
Description
Development 100 mm diameter InP/Si laminate substrates to enable development of a cost-effective, scaleable fabrication of InP based multijunction cell process, opening up a new design space for high-efficiency multijunction solar cells.
Target Efficiency — **>40%**



a) Bottom Cell for Mechanically Stacked Multijunction Cell

b) Lattice-matched InP-based Triple Junction Cell

Resources ($)		
Total Project	DOE Funds	Cost Share
$1,065,799	**$837,000**	**$228,799**

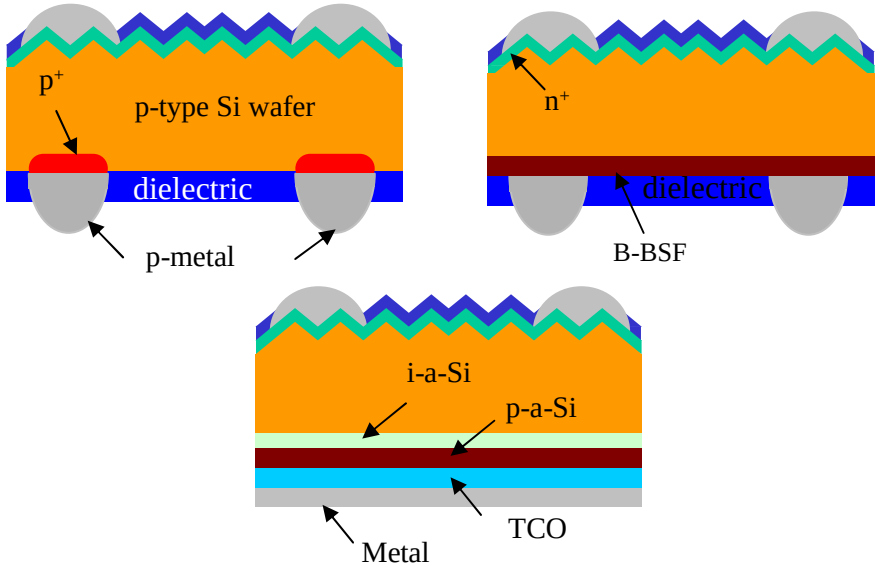
Dr. Harry Atwater

Georgia Institute of Technology
with SiXtron Advanced Materials, Inc.

Rear Contact Technologies for Next Generation High-Efficiency Commercial Silicon Solar Cells

Technologies Addressed
Low cost monocrystalline and multicrystalline silicon solar cells
Description
Develop enhanced, cost-effective back surface passivation, light trapping, and inkjet printed back contacts, to yield a complete, low-cost, cell process which is ready for commercialization.

Target Efficiency	17-20%



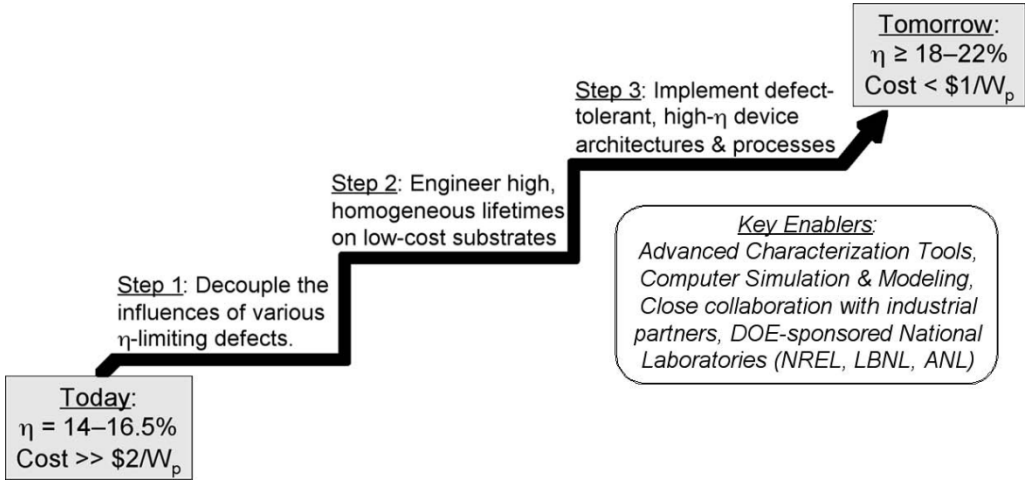
Resources ($)		
Total Project	DOE Funds	Cost Share
$1,875,000	**$1,500,000**	**$375,000**

Dr. Ajeet Rohatgi

Massachusetts Institute of Technology
with CaliSolar, Inc. and BP Solar International, Inc.

Defect Engineering, Cell Processing, and Modeling for High-Performance, Low-Cost Crystalline Silicon Photovoltaics

Technologies Addressed
Low-cost monocrystalline and multicrystalline silicon solar cells
Description
Close the efficiency gap between industrial multicrystalline and high-efficiency monocrystalline silicon cells, while preserving the cost advantage of low-cost, high-volume substrates.
Target Efficiency | **18-22%, <$1/W$_p$**



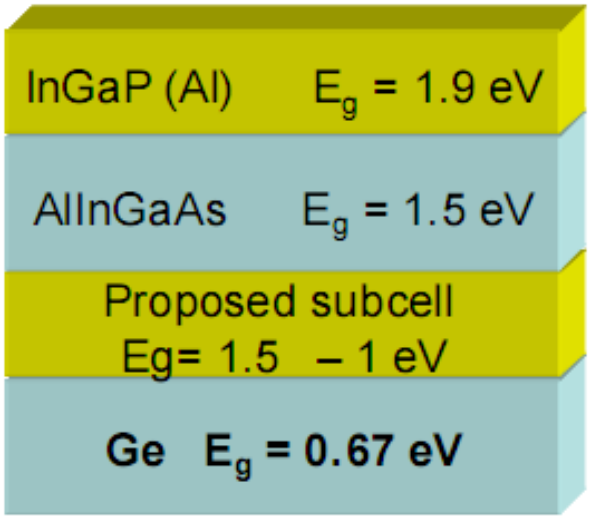
Resources ($)		
Total Project	DOE Funds	Cost Share
$1,886,327	**$1,500,000**	**$386,327**

Dr. Tonio Buonassisi

North Carolina State University
with Spectrolab, Inc.

Tunable Narrow Bandgap Absorbers for Ultra-High-Efficiency Multijunction Solar Cells

Technologies Addressed
High-efficiency 4-junction cells for CPV systems
Description
Develop and optimize a 1-1.5 eV, graded strain subcell and then integrate this layer into Spectrolab's triple junction device to produce a higher efficiency four junction solar cell.
Target Efficiency — **45%**



Resources ($)		
Total Project	DOE Funds	Cost Share
$1,434,420	**$1,147,468**	**$ 286,952**

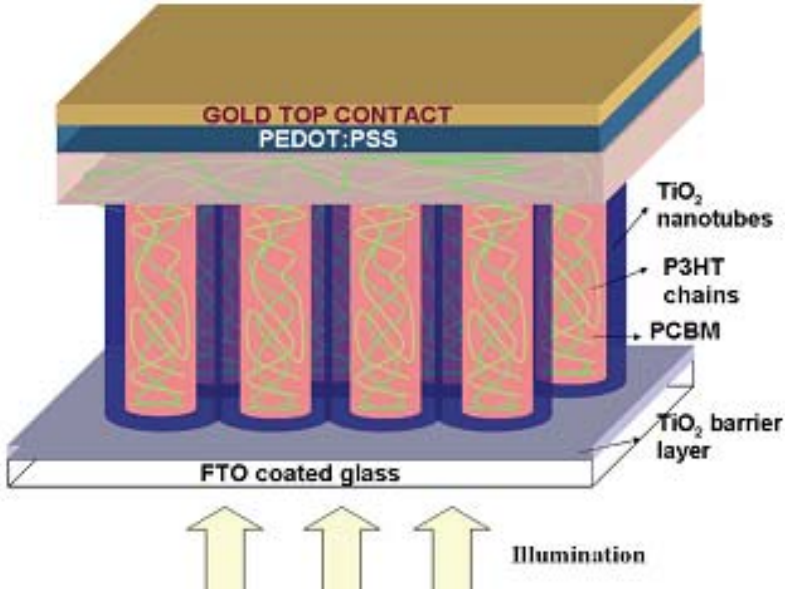
Dr. Salah M. Bedair

Pennsylvania State University
with Honeywell International, Inc.

Organic Semiconductor Heterojunction Solar Cells for Efficient, Low-Cost, Large-Area Scalable Solar Energy Conversion

Technologies Addressed
Organic cell with ordered TiO_2 nanotube arrays
Description
Use high surface area TiO_2 nanotube arrays in combination with electron and hole transporting organic semiconductors to fabricate inorganic-organic hybrid hetrojunction solar cells.

Target Efficiency	>7%



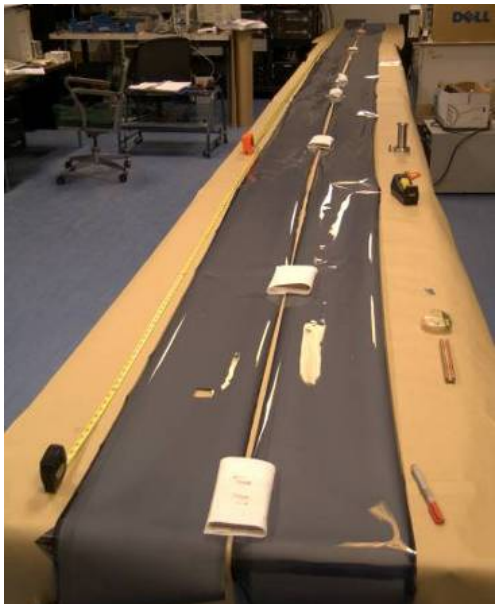
Resources ($)		
Total Project	DOE Funds	Cost Share
$1,539,803	**$1,231,843**	**$307,960**

Dr. Craig Grimes

University of Delaware Institute of Energy Conversion with Dow Corning

Development of a Low-Cost Insulated Foil Substrate for CIGS Photovoltaics

Technologies Addressed
Insulating substrate for high-temperature CIGS deposition
Description
Develop a low-cost stainless steel flexible substrate coated with silicone-based resin dielectric and monolithic integration technology applicable across a variety of roll-to-roll (R2R) CIGS manufacturing techniques.
Target Efficiency — **R2R devices ≥ 12%**



Resources ($)		
Total Project	DOE Funds	Cost Share
$1,848,024	**$1,478,331**	**$369,693**

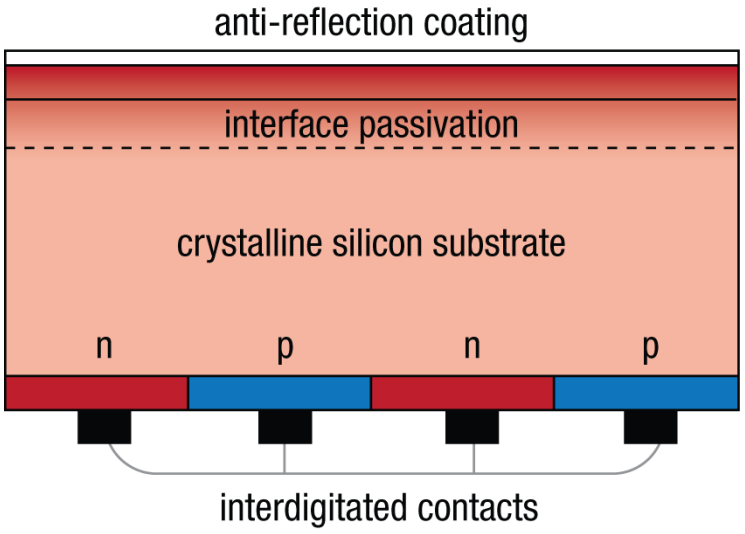
Dr. Erten Eser

University of Delaware Institute of Energy Conversion with SunPower Corporation

High-Efficiency Back Contact Silicon Heterojunction Solar Cells

Technologies Addressed
High-efficiency back contact silicon solar cells
Description
Develop low-temperature passivation, low-cost metallization and low-cost cell structures to fabricate rear interdigitated back contact hetrojunction solar cells.

Target Efficiency	>26%



Resources ($)		
Total Project	DOE Funds	Cost Share
$1,870,903	**$1,494,736**	**$376,167**

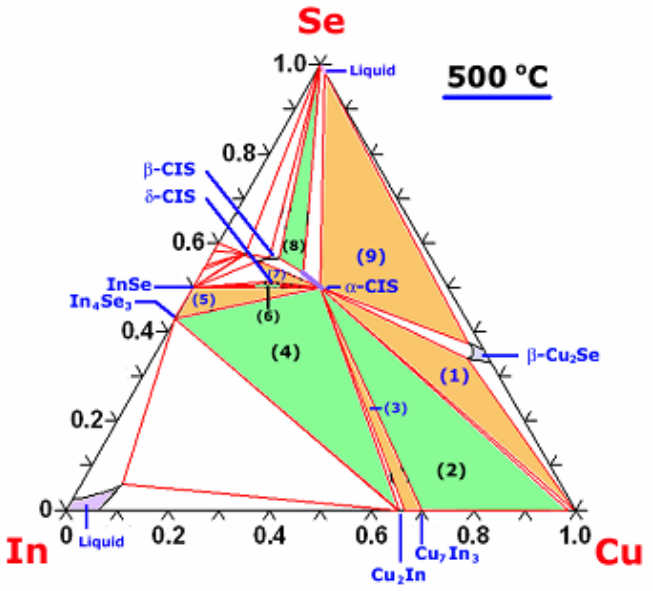
Dr. Stuart Bowden

University of Florida with Global Solar Energy Inc., International Solar Electric Technology Inc., Nanosolar Inc., Solyndra Inc.

Routes for Rapid Synthesis of CIGS Absorbers

Technologies Addressed
High-rate deposition CIGS
Description
Develop predictive models that quantitatively describe reaction pathways to synthesize CIGS which will reduce synthesis processing time and identify scaling issues for commercial manufacturing.

Project Target	CIGS synthesis ≤ 2 min



Resources ($)		
Total Project	DOE Funds	Cost Share
$760,863	**$599,556**	**$161,307**

Dr. Tim Anderson

University of Toledo with Calyxo USA, Inc.

Improved Atmospheric Vapor Pressure Deposition to Produce Thin CdTe Absorber Layers

Technologies Addressed
Commercial CdTe modules
Description
Develop 10% efficient modules which utilize CdTe absorber layers approximately 1µm thick. Improvements to contacts, uniformity, and monolithic integration will also be achieved.
Target Efficiency | **10%**

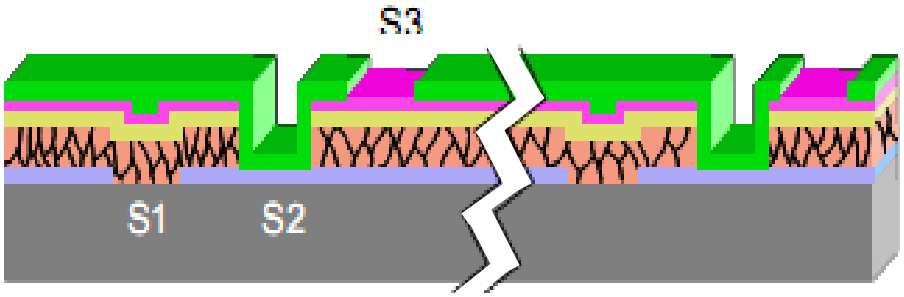


Figure 1: Three Scribe sequence shown for Calyxo USA monolithically integrated CdTe module.

Resources ($)		
Total Project	DOE Funds	Cost Share
$1,657,358	**$1,164,174**	**$493,184**

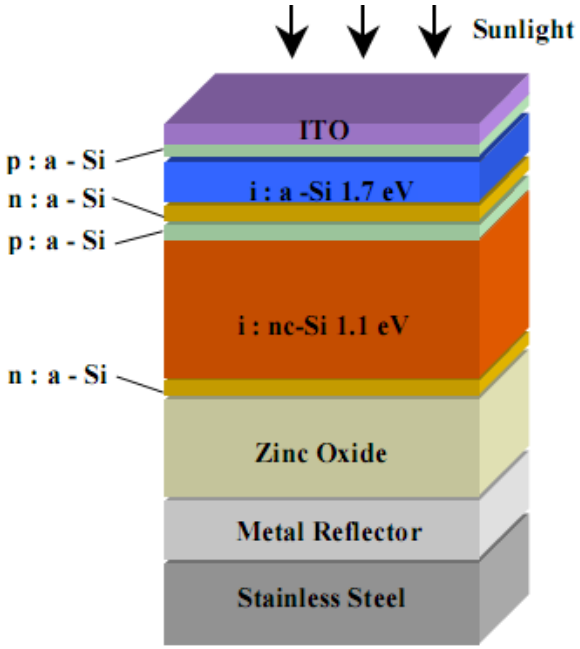
Dr. Robert W. Collins

University of Toledo with Xunlight Corporation

High Rate Fabrication of a-Si-Based Thin-Film Solar Cells Using Large Area VHF PECVD

Technologies Addressed
Amorphous silicon thin-film modules
Description
Develop uniform large-area (3 ft x 3 ft) VHF PECVD processes for fabrication of high-efficiency amorphous silicon and nanocrystalline silicon (nc-Si) solar cells at high rates.

Target Efficiency	10%



Resources ($)		
Total Project	DOE Funds	Cost Share
$1,895,798	**$1,442,266**	**$453,532**

Dr. Xunming Deng